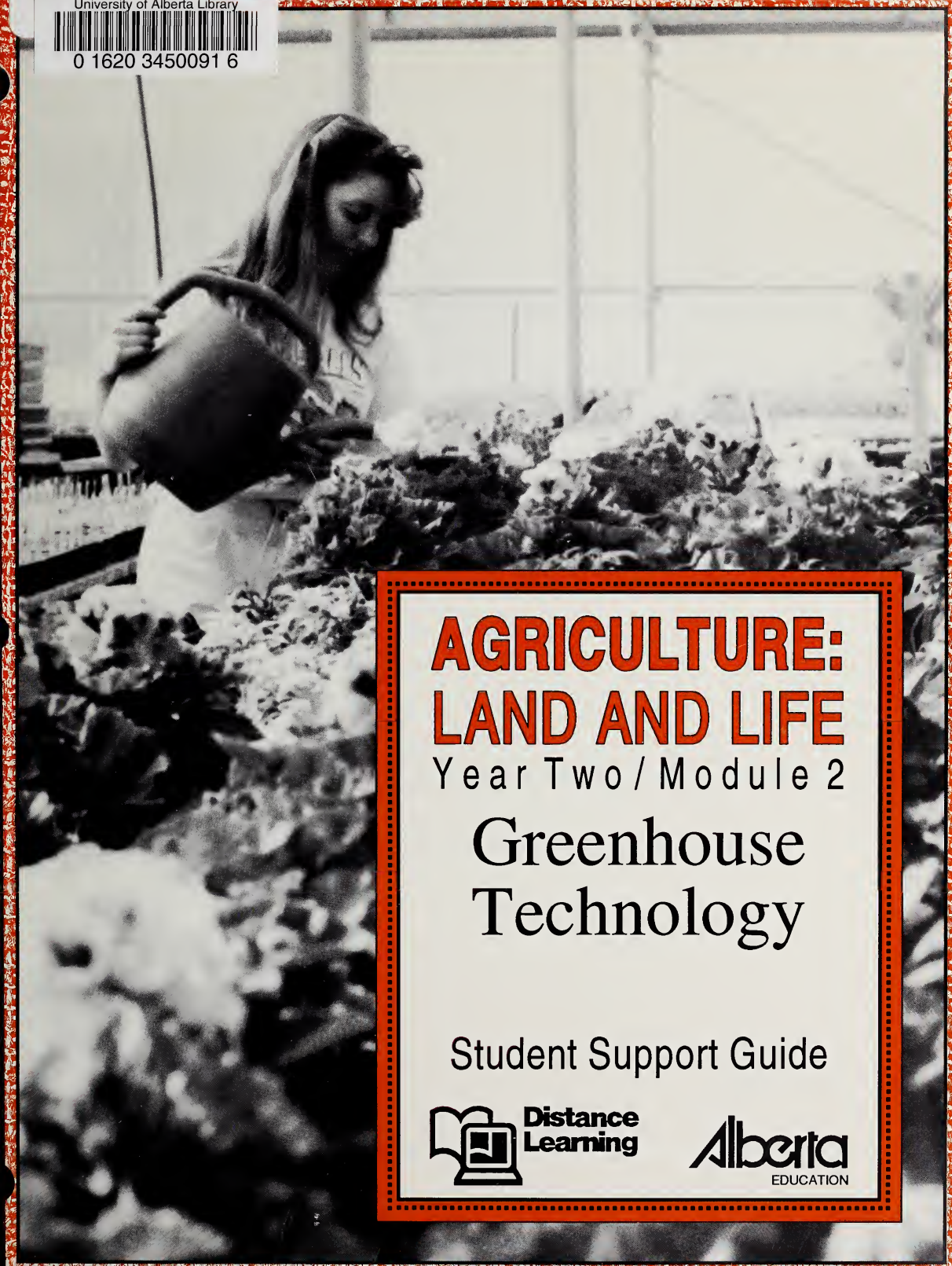


AGRICULTURE: LAND AND LIFE

Year Two / Module 2

Greenhouse Technology

Student Support Guide

Distance Learning

Alberta EDUCATION

Agriculture: Land and Life Year Two

Module 2

STUDENT SUPPORT GUIDE

Note to the Parent or Guardian

This Student Support Guide contains answers to activities in the Module Booklets. It should be kept secure by the parent or guardian if the student is under 16 years of age. Younger students should not have access to this Guide except under supervision.

This Student Support Guide does not contain the answers to the Assignment Booklets. The Assignment Booklets will be graded by the student's distance education teacher.

Agriculture: Land and Life Year Two
Student Support Guide
Module 2
Greenhouse Technology
Alberta Distance Learning Centre
ISBN No. 0-7741-0485-6

Module 2: Greenhouse Technology – Overview

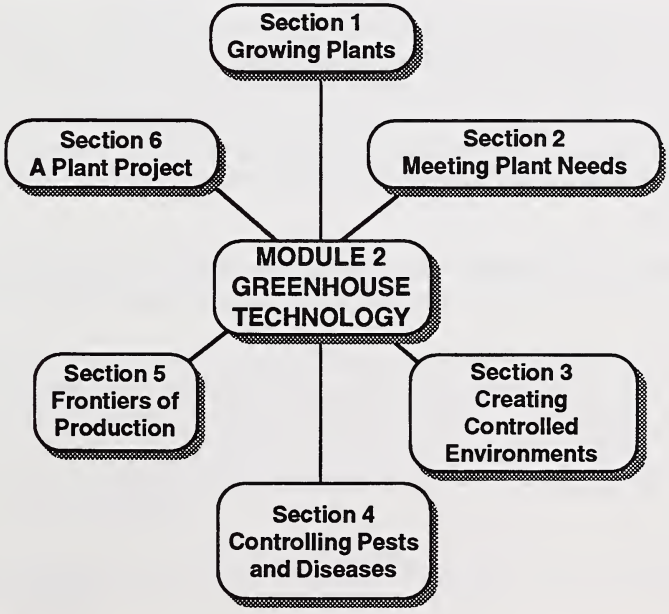
Farming can be thought of as a series of interventions in a natural process to maximize crop production. The growing of plants – both commercially and in the home – requires a high degree of skill and responsiveness to plant needs. Such decisions as how and when to seed, when to fertilize, or how to control pests and diseases, depend on a range of conditions that need to be monitored in order for appropriate action to be taken.

Horticulture is the growing of plants whereby each plant receives individual attention. This topic is well suited to individual study and provides an opportunity to study plant growth in a controlled indoor environment. Greenhouse technology employs principles similar to those of growing plants in larger structures.

It is hoped that students will take advantage of the many opportunities for hands-on experiences with plants presented in this module. Because this module is about growing plants, Section 6: A Plant Project has also been included. Students may begin their plant project after completing Section 2 of this module.

In this module students will

- discover the many ways that plants can be propagated
- recognize that plants have needs that must be filled for optimum growth
- learn how to monitor and manage environmental conditions in a home to satisfy plant needs
- find out how environments are monitored and managed in greenhouses and growth structures
- meet some common plant pests and learn about pest controls
- speculate how new developments in greenhouse technology might provide benefits



Evaluation

The student's successful completion of all assignments in the Assignment Booklet will depend on practice obtained while doing the various activities in the Student Module Booklet. In this module students are expected to complete five section assignments.

The following distribution of marks will determine the student's grading for this module.

Section 1 Assignment	**25 marks**
Section 2 Assignment	**25 marks**
Section 3 Assignment	**25 marks**
Section 4 Assignment	**15 marks**
Section 5 Assignment	**10 marks**
TOTAL	**100 marks**

Note: The evaluation of the assignments for this module does not include an evaluation of Section 6: A Plant Project. The project is to be evaluated as part of Module 4.

Each module for the Agriculture: Land and Life Year Two course is worth 25% of the total final grade, based on an equal weighting of the four modules in this course.

Project Work

If this is the first year that the student is in the Agriculture: Land and Life program, then the student does not need to complete Section 6: A Plant Project. Instead, Part A of Module 4: What Is Agriculture? will need to be completed.

If the student has previously taken Year One of the Agriculture: Land and Life program, then he or she has an opportunity to pursue an interest in particular topics during the Year Two program. Students are expected to complete two individual projects as part of the requirements for this course. Descriptions for a plant project (Project 1) are included as part of this module, and descriptions for an animal project (Project 2) are included as part of Module 3. Approximately 7.5 hours are allowed for the book work for each project. The actual time spent pursuing each of the projects will be more than 7.5 hours.

In Section 6 of the module booklet, students will find instructions on how to complete a plant project of their choice. A report on the project will be submitted in the Module 4 Assignment Booklet, Part B.

There are 50 marks for the plant project. The following is a breakdown of marks for the plant project assignments that are to be submitted in the Module 4 Assignment Booklet, Part B.

Assignment	Value
Project 1: Section 1	5
Project 1: Section 2	5
Project 1: Section 3	15 or 5
Project 1: Section 4	20 or 30
Project 1: Section 5	5
TOTAL MARK	50

Materials Needed for Module 2

This module has been designed to provide students with many opportunities for hands-on activities with plants.

In order to assist students effectively in their study of this module, it may be helpful to preview Module 2. This will give you an idea of how the topics are developed; it will also give you an overview of the materials needed in the module. In some cases, if the materials suggested are not readily available, the learning facilitator may be able to substitute suitable materials for the student, so that the activities can be completed successfully.

If students are working on this module in the spring or fall, there should be no trouble finding the materials needed for the activities. However, if this module is worked on in the winter, some advance planning will be required. Some materials should be collected ahead of time so they are available when needed.

1. Several types of plants should be collected, pressed, and dried in the fall. Later on, students can have a closer look at these plants.

2. Seeds from various plants (wild plants, field crops, garden vegetables, or flowers) that students would like to grow under controlled conditions in indoor environments should be gathered.

3. Several litres of garden soil and other growing mediums such as vermiculite, peat, and perlite, will be needed to make potting soil and to compare soil to soilless mixes. As an alternative, premixed potting soil may be purchased.

4. Containers (plastic starting trays or small flower pots) for growing plants will be needed.

Media

The videotape resources for this module may be available from the Alberta Distance Learning Centre, or call your local school authorities.

The video program suggested as an optional learning pathway in this module is *Pest Wars*, a 28-minute VHS videotape.

Section 1: Growing Plants

This section contains enough basic botany for students to be able to propagate plants for further activities or projects. For further information students can be referred to the Grade 8 science program. This material is covered in much more detail in the Grade 8 science unit – Growing Plants.

Section 1: Activity 1

Note: Students are to do either Part A or Part B.

Part A

If working alone, the student should obtain a garden plant or weed and compare the parts of the plant to the plant pictured in the Student Module Booklet.

If students are part of a class, they should try to study examples of various plants found around the school. If possible, they should study wild plants rather than cultivated plants.

1. Draw a picture of your plant. Name all of its main parts.

   Drawings will vary depending on what plant the student selects, but the plant drawing should have the main parts labelled, such as roots, stems, leaves, and flowers. Other parts that may be labelled on the diagram could include root hairs, leaf stems, true stems, woody stems (trunk), horizontal stems, stems and runners, bulbs or tuberous roots, fleshy roots, and flowers of various types. The various reproductive parts of flowers may be shown.

2. Describe how each part is important to the plant.

   Students should note a description of the importance of each part that they labelled on the plant in question 1. Answers will vary. Some sample answers follow:

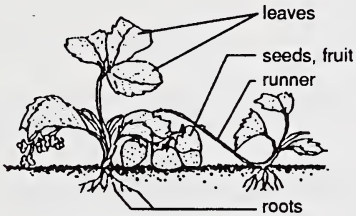
   - *Flowers contain reproductive parts which are important for the reproduction of plants.*
   - *Leaves manufacture food by the process of photosynthesis.*
   - *Stems transport nutrients and support the leaves.*
   - *Roots anchor the plants and take up water and minerals from the soil.*
   - *Horizontal stems or runners help to make new plants.*

3. Why do you think there are so many different plants?

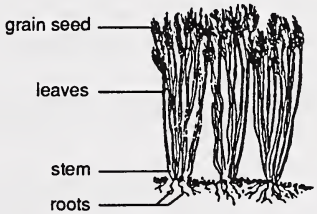
Answers will vary. Different plant parts have a variety of functions which allow different plants to become adapted to grow and survive in varying environmental conditions. Plants are grown for many different purposes – people may grow plants for food purposes or for cultural beauty.

Part B

4. Examine the drawings of the following plants and name the parts of each plant which provide each listed function. (Some parts are not labelled on the drawings.)

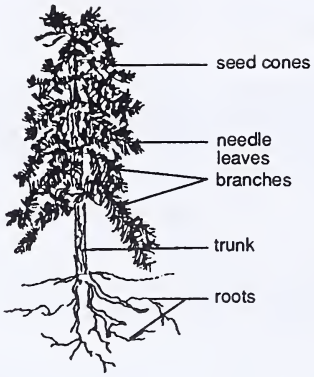


Strawberry Plant

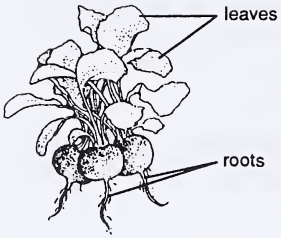


Wheat

	Strawberry Plant	Wheat
• Photosynthesis	*leaves*	*leaves*
• Nutrient uptake	*roots*	*roots*
• Food storage	*fruit, roots*	*grain seed*
• Support	*stem, runner, roots*	*stem, leaves, roots*
• Transport of nutrients	*stem, runners*	*stem, leaves*
• Reproduction	*seeds, fruit, runners*	*grain seed, tillers*



Pine Tree



Beet

• Photosynthesis	*needle leaves*	*leaves*
• Nutrient uptake	*roots*	*roots*
• Food storage	*needle leaves*	*roots*
• Support	*trunk, woody stems, roots*	*roots, stems*
• Transport of nutrients	*trunk, branches*	*stems, leaves*
• Reproduction	*seed cones*	*flower*

5. List and classify the common plants around your home. Seed catalogues, gardening books, or encyclopedias will help you provide this information.

Plants which prefer to propagate by seed are often annuals, while vegetables with fleshy roots are often biennials. Woody plants and any plants that propagate from bulbs are generally perennials. Many examples can be identified from books on home gardening. The following are some of the more common examples. Students are to list only six examples for each group.

Annuals	***Biennials***	***Perennials***
carnation	*English daisy*	*lily (many kinds)*
snapdragon	*foxglove*	*delphinium*
marigold	*mullein*	*rose*
petunia	*pansy*	*iris (many kinds)*
alyssum	*cabbage*	*gladiolus (many kinds)*
wax begonia	*beet*	*tulip*
beans	*carrot*	*peonies*
lettuce	*turnip*	*chives*
wheat	*parsnip*	*rhubarb*

Section 1: Activity 2

1. Write a short paragraph describing the changes you would notice in your environment if plants did not propagate. Which plants would disappear first? How might this affect you?

   The first plants to disappear would be the annuals and biennials, followed by the shorter-lived perennial plants. The effect would include a buildup of CO_2 and a reduction of O_2 in the atmosphere. Food supplies from plants and animals would also disappear.

2. If you doubt that bulbs or tubers are stems, try leaving one out in the bright sunlight. It will turn green! Why is this?

   The chlorophyll in the bulb or tuber (which is really a modified stem) will be activated by sunlight and begin to produce food. The bulb or tuber will take on a green colour.

3. Various plants are shown on the following page. Examine the pictures, and answer the following questions.

   a. Name the propagation method being used by each of the plants shown.

      - **flowering annual plant** – *seeds*
      - **gladiolus** –*bulb*
      - **potato** – *tuber*
      - **spider plant** – *runners*
      - **Aspen tree** – *suckers, seeds*

   b. Which type or types of propagation shown will produce plants with the characteristics of two parent plants?

      Flowering annual plants will produce plants with the characteristics of two parent plants.

   c. Which type or types of propagation will produce plants that are most similar to the parent?

      The types of propagation that will produce plants most similar to the parent are those with bulbs, tubers, runners, and suckers.

4. Suppose you need a large number of plants for flower beds in the spring. Which propagation method would you use?

   Propagate from seeds if the number of plants are more important than the speed at which they are grown.

5. A fern is getting too large for your home. What could you do to save the plant?

   You could divide the root ball and repot the fern divisions into smaller containers.

6. Your younger brother or sister broke a branch off your mother's favourite plant. How could you use the broken branch for propagation?

   You could propagate a new plant by using the branch as a stem cutting.

7. You would like to grow a new plant from an original plant as quickly as possible. How would you do it?

   Many plants, particularly perennial plants, are started more quickly from leaf cuttings or stem cuttings. Gather slips from branches and allow the slips to root in a soilless starting medium.

Section 1: Activity 3

In this activity students will be given an opportunity to try growing new plants. They will need to use the information from Activity 2 to choose methods of plant propagation that they would like to try. The Appendix at the back of the Student Module Booklet lists plants that are best suited for each propagation method, but additional ideas can be obtained from gardening books found in the library. Extra Help in this section suggests ways for students to locate starting materials for propagation activities.

The number of plants to propagate by each of the chosen methods will depend on the needs of the project that the student wishes to do. It is always better to have too many plants rather than not enough.

Refer students to the Project Section (Section 6). They may want to propagate a particular type of plant for one of these projects. They may start these plants while doing this activity.

Choosing Your Methods

Use the information from the previous activity to help you choose two methods of plant propagation. You will also grow some plants from seed as a third method.

1. Write down your choices. If you have a particular plant in mind, name this plant.

   a. Your Choice of Propagation Methods
   b. Names of Plants
   c. How will you obtain your seeds or plant materials?

   Answers will vary for a, b, and c.

Gather Your Materials

Students will check and discuss their plant propagation choices with the learning facilitator. Check to see that their objectives can be achieved. In the Appendix you will find a detailed description of eight ways in which plants can be propagated. Check to see that the students have gathered the necessary materials to complete this activity.

Make Your Own Starting Medium

2. Write down the recipe that you plan to use.

   Answers will vary. Students will show their soilless mix to the learning facilitator and explain how it was made. Descriptions of various soilless mixes, along with guidance on how to make various starting mediums, are outlined in the Student Module Booklet.

3. Propagate your plants using the three methods that you have chosen and the starting medium or mediums that you have made. If necessary, read the appropriate sections of the Appendix.

   Students will demonstrate and discuss their three methods of propagating plants with their learning facilitator.

Ask your students to fill in the appropriate sections of the Plant Journal in the back of their Module 2 Assignment Booklet, using one page for each type of plant that they propagate. While the plants are germinating students should continue working on other activities in their module booklets. They will be given frequent reminders to check on the progress of their plants, and to record the progress of their propagating plants in the Plant Journal.

Section 1: Follow-up Activities

Extra Help

If students are having trouble locating starting materials for propagation activities, they may find the following suggestions useful.

- **Extract seeds from a tomato, cucumber, wild oats, or another available plant, or use dry mustard seeds or dried beans.**
- **Take a potato and cut it with a knife so that you have about a 2.5 to 5 cm cube of potato with one eye (dimple) in it. This will act as propagation by tuber.**
- **Plant a small onion (bulb) for propagation by bulb.**

Note: Seeds from a fruit are difficult to germinate and the plants grow very slowly. Students would need to plant many seeds and be prepared to wait a long time. As a result, fruit seeds are not recommended for these activities.

Test Yourself

1. Propagation means to

   multiply or make more of something

2. What are two advantages of using soilless mixes to start or grow plants?

   Sample answers follow:

   - *They are free of insect pests and diseases.*
   - *They are free of weed seeds.*
   - *They are easier to work with for the above reasons.*

3. What can a soilless mix for plants be made out of?

   A soilless mix for plants can be made of coarse sand, perlite, peat, vermiculite, synthetic media such as rock wool, cellulose, sawdust, or any other porous medium.

Check to see that students have attempted to propagate some plants.

Watching plants grow is a main component of this module. Everyone should be able to start plants with the methods presented. In extreme situations you may have to help students by supplying materials or helping with the physical demands of the activities. Observe student activities if possible.

Enrichment

Enrichment A

1. Which mediums failed to produce a plant?

   Seeds may have trouble germinating in dry, compacted, or acidic environments.

2. Which mediums resulted in the fastest germination?

   Seeds will germinate fastest in moist environments.

3. Which mediums remained moist? Which dried out?

   Answers will vary. Mediums containing vermiculite or peat tend to retain moisture well. Mediums containing high percentages of sand tend to dry out quickly.

4. Which mediums produced the longest roots, and have started to develop root systems?

   Answers will vary. Mediums containing a mixture of materials or soil such as loam may allow for better root system development. Once germination is complete roots are needed to feed the plants.

5. Based on what you see, try to design a mix which supports germination, holds moisture, promotes root development, and holds together well enough to support the plant.

   Answers will vary. The mix will likely contain a combination of materials. For example, it may contain sand, perlite, or garden soil to improve drainage and promote root development to support the plant, and vermiculite or peat for holding water. Limestone may be added to reduce acidity if peat is used.

6. Could your plant survive in a soilless mix? Is something missing?

   Soilless mixes contain no nutrients. Before your plant grows very large, you will see signs of nutrient deficiencies.

Enrichment B

Use a film or video camera to record the growth of a seed that is germinating behind glass. If you do not have a camera, this could still be fun to watch!

Briefly describe the changes you saw in the growth of a seed over a period of time.

Check over the descriptions and, if the students have pictures showing the growth of germinating seeds, encourage them to show their pictures to other agriculture students.

Note: The student should now complete either Part A or Part B of the assignment for Section 1 in the Module 2 Assignment Booklet. Part A involves writing a report about the plants which the student started growing while doing the activities for Section 1. The student is to monitor and manage the growth of these plants while continuing to work on other sections of Module 2. The questions for Part A will need to be answered as the plants grow and mature. The information that the student enters into the Plant Journal, located at the end of the Module 2 Assignment Booklet, will serve as a resource for answering the Part A questions. If students are unable to grow plants, or if their attempts are unsuccessful, then the questions about plant propagation in Part B may instead be completed.

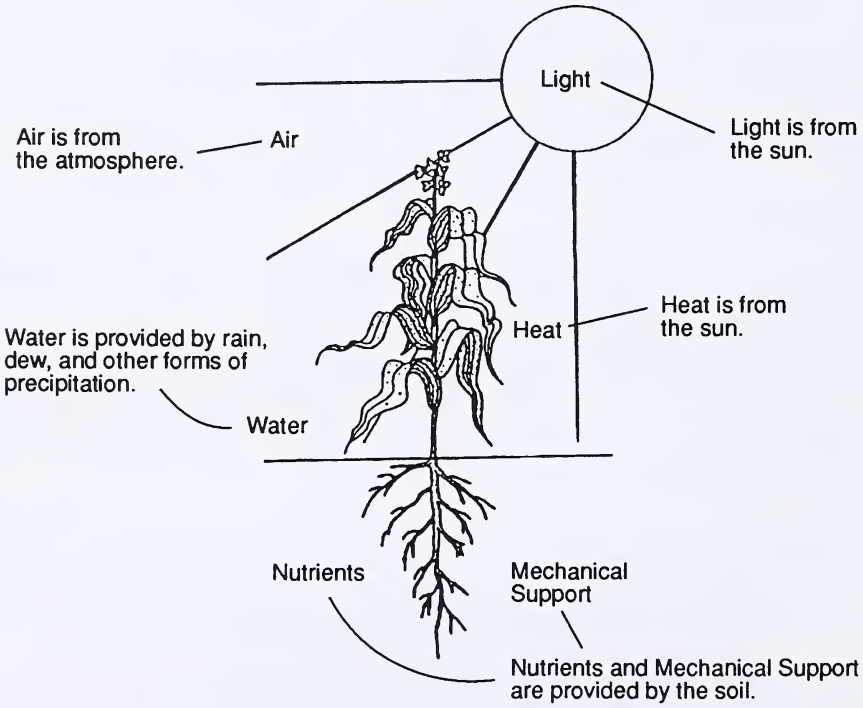
Section 2: Meeting Plant Needs

This section is designed to make students aware of basic plant needs that must be met for the plants to thrive and grow.

Section 2: Activity 1

In this activity students will be presented with some new ideas, and a number of demonstrations to try. They are expected to attempt as many of these demonstrations as they can and share their observations with their learning facilitator.

1. Consider the following corn plant. Beside each of the needs stated on the diagram, state your ideas as to how nature provides the plant with each of these needs.



[1]

[1] Alberta Agriculture for the graphic from *Alberta Soils Course*. Adapted by permission of Home Studies Section, Education Branch, Alberta Agriculture.

2. Draw a picture of what you see.

In the first demonstration that students are to try, they are to colour a glass of water with blue food colouring and place a carrot or piece of celery (with green leaves attached) in the water for a day. They are then to cut the carrot or celery lengthwise and across, and examine the channels under a magnifying glass.

The student drawing should show the water-conducting channels as dots in the cross section and as streaks in the long section.

3. Why does this change happen?

Water is taken up by plant cells. The cells inflate with water and become more rigid – this provides structural support for the plant.

4. How can you help a plant that is dry and wilted?

If a plant is dry and wilted, give it water!

5. Name the three ways in which water is used by plants.

Water is used for

- *the transport of nutrients*
- *photosynthesis*
- *the support of plant tissues*

6. How might you prevent plants from drowning?

You can prevent your plants from drowning by allowing the excess water to drain.

7. Can you name the two products of photosynthesis?

Two products of photosynthesis are glucose (sugar) and oxygen.

8. How are these products important to you?

Glucose is stored in plant material as food for plant growth and propagation. People and animals also use plant material as food. Oxygen is released into the air, and is needed for respiration.

9. What has happened to the stalk?

Students should wrap a celery plant in dark paper with the leaves exposed to the light, then set it upright with the base in water for several days to see if any changes happen to the celery.

The stalk should turn white.

10. How does the plant respond?

Students should turn a houseplant, or other plant, so that its leaves face away from the light source, then observe what happens.

The plant leaves turn toward the light. This is called phototropism.

11. Do you see water droplets forming on the inside of the cover over your plant? What causes this?

Students should try making a "greenhouse" for a small plant by cutting off the bottom third from a two-litre clear plastic soft drink bottle, and using the upper two-thirds of the bottle as a dome cover.

The water given off during transpiration raises the humidity inside the greenhouse. As well, the air temperature is usually higher inside the greenhouse than it is outside. Moisture condenses from the moist, warm air as it touches the outer wall.

12. Imagine how a lack of nutrients would affect your plant. Write down your predictions.

A lack of nutrients could affect the plant in many ways, depending on what nutrient or nutrients are missing. Signs may be

- *slow or zero growth*
- *unusual leaf colour – pale or bluish*
- *abnormal growth*
- *spotted and dying leaves*

13. How is a germinating seed different from a growing plant? Where does the food stored in the cotyledon come from?

Germinating seeds depend on food that has been stored in the cotyledon of seeds, while growing plants manufacture their own food. Some of this manufactured food produced by growing plants is stored in the cotyledons.

Did each student remember to fill in the appropriate sections of the Plant Journal in the back of the Assignment Booklet?

Section 2: Activity 2

In this section students will practise plant care techniques using real plants in their home or school. Most of these activities are practical in nature. Students will quickly become confident in their ability to care for plants. It is very difficult to damage a plant with any of the methods presented here.

1. How would you tell the difference between a wilted plant that needs water and a wilted plant that has been overwatered?

   Check the soil – if it is not dry, do not add more water.

2. Decide whether the following statements are **True** or **False**. If false, state why the statement is false.

   a. If a plant looks wilted, it always needs more water.

      ***False**. The plant may be wilted due to overwatering.*

   b. Plants grow best in damp (but not soaked) soil.

      True

   c. If soil is up to the top of the pot, watering is easier – you do not have to water so often.

      ***False**. Space is needed at the top of the pot to add enough water to thoroughly soak the soil.*

   d. The best time to water plants is in the morning, soon after the sun begins to shine.

      True

   e. Plants prefer to drink fresh cold water.

      ***False**. Room temperature water should be used.*

   f. It is okay to let the top of the soil in the pot become dry.

      True

g. All plants regardless of type, size, and location should be watered at the same time each week.

False. *Plants should be watered when the surface of the soil is dry, and the soil has begun to shrink away from the edge of the pot.*

h. Plants like rainwater better than water from the tap.

True

i. If watering from the top, care has to be taken not to wash out small plants.

True

3. Why do many houseplants grow best in moist, warm air?

Most houseplants are imported from tropical climates.

4. Write down the type of lighting preferred by the plants that you have started.

The best lighting for my plants is the following:

Answers will vary, depending on the types of plants selected. Instructions on the seed packages or descriptions in seed catalogues and horticultural guides often supply this type of information. Plants such as asters, chrysanthemums, and goldenrods, which bloom in the spring and fall, or in partial shade during the summer, require less light than plants such as petunias and hollyhocks, which bloom best in the summer.

Did each student remember to add the information from question 4 to the Plant Journal in the back of the Assignment Booklet?

5. Decide whether the following statements are **True** or **False**. If false, state why the statement is false.

a. Plants use light to give themselves a green suntan.

False. *Plants use light energy to manufacture food energy. Chlorophyll, the green substance in leaves, makes this possible.*

b. Plants need light to make food.

True

c. If plants are exposed to too much light, they will "sunburn" something like you would.

True

d. All plants require the same amount of light.

False. *Some plants will flower only if they receive full sunlight, while other plants will only bloom in shady places.*

e. Plants can live without sunlight.

True *(for a short time)*

6. The best temperatures for my plants are

Answers will vary. Desert and tropical plants prefer higher temperatures than most plants that are native to this area.

Did each student remember to add the information from question 6 to the Plant Journal in the back of the Assignment Booklet?

7. How much of each nutrient is present in a fertilizer with the number 5-20-10?

Nitrogen: *5%*
Phosphorus: *20%*
Potassium: *10%*

8. A plant that is deficient in certain nutrients will provide you with symptoms of its problem. In the following chart, see if you can determine what mineral the plant is deficient in and what fertilizer could be used to solve each problem based on the symptoms given.

Symptoms	Deficiency (underline one)	Fertilizer (underline one)
The leaves are turning pale green and growth is slow.	Nitrogen Phosphorus Potassium	27-14-0 16-20-0 0-0-50
Some leaves are mottled – curled under. The lower leaves are dropping off.	Nitrogen Phosphorus Potassium	27-14-0 16-20-0 0-0-50
The plants are smallish and fail to flower.	Nitrogen Phosphorus Potassium	27-14-0 16-20-0 0-0-50

Section 2: Activity 3

Students should now check their propagating plants to see if they have developed roots and are ready to be transplanted. Many will have grown seedlings that can be repotted or moved outdoors. Students should follow the guidelines given in the Student Module Booklet about when to transplant.

1. What would be the disadvantage of filling the pot to the top with soil or a rooting medium?

   The plant would be difficult to water from the top.

2. What would be the disadvantage of filling the pot only half-full with soil or a rooting medium?

   There would be less soil to hold moisture, so the plant would need to be watered more often. There would also be less soil for the plant to get nutrients from and less soil to anchor the plant firmly.

Students can follow the method outlined in their module booklet to pot their plants. Students should show the repotted plants to the learning facilitator.

Did your students remember to measure the growth of their plants and fill in the appropriate sections of the Plant Journal?

Section 2: Follow-Up Activities

Extra Help

Fill in the blanks in the following paragraphs.

Plants have six basic needs which include *air, heat, light, moisture, nutrients,* and *support.* All of these needs must be satisfied if the plant is to reach its maximum potential.

Water is used by plants for *transport* of nutrients, *photosynthesis*, and *support* of plant tissues. Most of the water used by a plant is given off during *transpiration.* Plants lose moisture more quickly at higher *temperatures* and lower *humidities.* When a plant loses moisture faster than it can be transported from the roots, the plant begins to *wilt.*

The energy plants use for growth comes from *visible* light. Plants also need energy in the form of *heat.* The amount of this energy determines the rate at which plants grow. You can increase the energy available to plants in special structures called *greenhouses.* The most important use of light energy is for *photosynthesis.* By this process, plants store light energy as food. Because plants differ in the amount of *light* they require, this part of their environment must also be controlled.

Plants obtain nutrients for growth from *air*, *water*, and *soil.* When growing plants in a soilless medium, you must supply nutrients in the form of *fertilizer.* The three nutrients most often missing from soils are *nitrogen*, *phosphorus*, and *potassium.*

Enrichment

Enrichment A

This is a practical activity in which students can build confidence in working with plants by cleaning and misting plants.

1. Explain why washing a plant's leaves helps it to breathe easier.

   Washing removes dust and dirt that clogs the pores (stomates) on plant leaves. This makes it easier for the plant to give off water vapour and take in carbon dioxide from the air.

2. Name three ways in which you can help the air around your plants have more moisture in it than the air in the rest of your home.

   You can increase moisture in the air by

   - *misting*
   - *placing several plants together on a tray bed of gravel and water*
   - *placing the plant in an enclosed chamber*

Enrichment B

For this activity students are to examine plants in their homes and evaluate how well each of the plants' needs are being met.

1. What problems were found in your plants?

   Answers will vary. The most frequent problems are such things as the following:

Symptoms	Possible Causes
• *brown or yellow leaves*	• *usually nothing – extreme temperatures are the usual cause*
• *white spots on leaves*	• *splashing with cold water when watering*
• *slow growth*	• *normal in winter – possible insufficient light or underfeeding*
• *wilting*	• *not enough water, too much heat, poor light, or there may be root damage from overwatering or overfertilizing*
• *white crust on the soil*	• *salt buildup – cured by removal of salt and watering well with good drainage*
• *collapse of a plant*	• *sudden environmental change*
• *mushy dark stem and rotting*	• *too much water in cold weather, poor drainage, poor ventilation, fungus infection encouraged by damp, cool conditions*
• *tips of leaves turn brown*	• *poor humidity, low potash, underwatering*
• *light green or yellowish leaves and stunted growth*	• *lack of fertilizer, particularly nitrogen*

2. What can you do about this?

   Answers will vary. Look for a connection between symptoms and causes. You might need to adjust such things as light, humidity, moisture, and the supply of nutrients to see if this improves the condition of the specific plant.

Note: The student should now complete the assignment for Section 2 in the Module 2 Assignment Booklet.

Now is a good time for students to begin a plant project of their own. They may turn to Section 6: A Plant Project and select a project that interests them. Some guidance and help will be required in the activities related to the project. When they have finished Activities 1 and 2 of Section 6, they should continue with Section 3.

Note: Section 6: A Plant Project is to be done only by those students who have already completed Agriculture: Land and Life Year One. Students who have started directly into the Year Two program without doing the Year One program of Agriculture: Land and Life do not need to do Section 6. They should continue now with Section 3.

Section 3: Creating Controlled Environments

This section is an introduction to the planning and skills required in greenhouse operations. Students will see how environments are controlled for best plant growth.

Section 3: Activity 1

1. What are some of the benefits of growing plants in controlled environments? List as many as you can.

   Advantages of growing plants in controlled environments include the following:

   - *You can overcome limits determined by temperature.*
   - *An ideal environment for special plants can be created.*
   - *Your surroundings can be beautified with indoor plants.*
   - *Weed and soil pest problems are avoided.*
   - *There is a better and more uniform quality among the plants.*

2. Describe each environment. (You may need to refer to some reference books for additional information.)

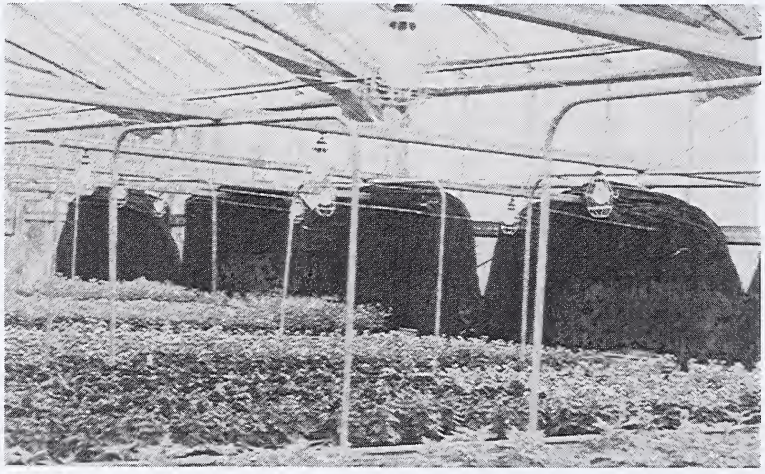
   a. **Tropical rain forest**: *This is a very humid environment due to the combined transpiration of so many plants, and frequent rains. Most plants live in the shade created by taller vegetation, because they will not tolerate very hot temperatures or bright sun. The length of night and day is similar because tropical areas are near the equator.*

b. **Temperate region**: *This region receives a lot of precipitation but temperatures are cooler than they are in tropical areas. There is a full range of seasons (distinct cool and warm or wet and dry seasons) with extremes of temperature and different lengths of day and night. Most plants that live in this region need a cool winter season as a rest period. This is required for budding to occur in the spring – buds are the small green shoots that form on the ends of branches where new growth begins each year.*

c. **Arid environment**: *This region receives little moisture. The plants are adapted to survive in dry conditions with bright sunlight. Deserts are found at many latitudes, mainly due to the lack of moisture. Cold deserts have a much different vegetation cover than hot deserts.*

3. Plants normally require a burst of reddish light at the beginning and end of the day to help regulate growth. How would you accomplish this in a greenhouse with artificial lights?

   You might use a source of red light, such as an incandescent lamp, for a short period in both the morning and the evening.



4. How might the curtains be used in this greenhouse? At what time of year?

   The curtains may be used in the summer to shorten the length of the day so that the short-day plants will bloom early.

5. What is the purpose of the incandescent lights? When might they be used?

   The incandescent lights may be used in both the morning and the evening to make the plant act as though the days are longer. Long-day plants will be fooled into blooming. You may also bring short-day plants into bloom during the winter months by simply controlling the hours of light that the plants receive.

6. Use the inverse square rule to find the intensity of a light from a high intensity lamp at the following distances:

Distance (metres)	1	2	4
Intensity (lux)	16 000	*4000*	*1000*

7. This relationship works well for any "point source" of light that is close to the observer. But what about light from the sun? Would you notice a change in the intensity of sunlight as you walk away from the sun? Why or why not?

   A change in the intensity of sunlight would not be noticed due to the great distance between the sun and the earth. Changes in distances on Earth from the sun are very small. Also the rays of light from the sun are essentially parallel for small areas.

8. At which times of the year is a good supply of natural light most critical for plant growth? Explain.

   Spring and autumn are the most critical times for lighting. This is when extra light is important to germinate or ripen crops. More than enough light is available in the summer. Natural lighting in winter is inadequate for some plants.

9. In what direction should a greenhouse be positioned to receive the most light at critical times of the year? Why?

   An east-west orientation would allow the best roof angle to be exposed to the sun for the greatest length of time.

10. What roof angle would best take advantage of natural light at the critical times of the year?

    The best angle of 64° is not practical. A compromise for most greenhouses is a roof angle of 26° when the slopes of both the north and south portions of the roof are considered.

11. How does the tree shown in the previous diagram help manage natural lighting in the greenhouse all year-round?

    When natural light is needed in the spring, the tree still has no leaves, but as days get longer and warmer, the tree gets leaves. These leaves help provide summer shade for the greenhouse. In autumn, as the weather gets cooler, the tree loses its leaves and more sunlight is able to reach the greenhouse. Because the tree has no leaves in winter, more light is available to the greenhouse.

12. Each row of the following table will allow you to compare a different type of lighting for a small greenhouse with dimensions of 10 m × 10 m.

    a. Calculate the number of lights you would need, and fill in the last column of the following table. The example just calculated has been entered for you.

    By using the calculation method described in the Student Module Booklet students should arrive at the number of lights needed, as given in the following chart.

TABLE 5-3 COMPARING LIGHTING ALTERNATIVES FOR SEVERAL DIFFERENT CROPS

Plants	Light Energy Required (mW/m^2)	Lamp Type	Lamp Size (Watts)	Light Energy Produced (Milliwatts)	Size of the Garden (m^2)	Number of Lights Needed
Tomatoes	20 000	Incandescent	100	6000	100	*333*
Tomatoes	20 000	Fluorescent	40	7800	100	*256*
Tomatoes	20 000	Mercury Vapour	400	63 000	100	*31*
Cucumbers	6000	Fluorescent	40	7800	100	77
Cucumbers	6000	Mercury Vapour	400	63 000	100	*10*
Strawberries	350	Fluorescent	40	7800	100	*4 to 5*

    b. Examine the numbers you have calculated. Is it practical to grow crops such as tomatoes or cucumbers by using incandescent or fluorescent lights? Why or why not?

    The large number of fixtures required for crops such as tomatoes and cucumbers makes this an impractical choice.

13. Which system might be most practical for

    a. **potted flowers**: *Spaghetti tubes and hand watering are best for potted plants.*

    b. **tropical gardens**: *Misting systems would resemble jungle rainfall.*

c. **commercial tomato or cucumber plants**: *Sub-irrigation systems are low-maintenance systems designed to handle rooted seedlings.*

14. Circle all results that exceed the noted acceptable limits. Are these mostly major nutrients or trace elements? How can you tell?

GREENHOUSE MEDIA ANALYSIS REPORT

Completed by:
Alberta Agriculture
Soils and Animal Nutrition Testing Lab

Submitter:
A Greenhouse Gardener
Alberta Distance Learning Centre

Sample Number: 25a Depth: 15 cm Date: Nov. 4, 1991

Analytical Results (in parts per million of water media extract)

Type of Analysis	Results	Acceptable Range
pH	5.6	5.5 - 6.9
Elec. Conductivity	(4.5)	0.8 - 3.0
Nitrogen (as nitrate) – N	(522)	35 - 180
Chlorine – Cl	(175)	0 - 30
Sulphur (as sulphate) – S	(153)	30 - 60
Phosphorus – P	(64)	5 - 50
Potassium – K	(454)	35 - 500
Sodium – Na	(32)	0 - 30
Calcium – Ca	(420)	60 - 400
Magnesium – Mg	139	30 - 200
Zinc – Zn	0.75	0.3 - 3.0
Copper – Cu	0.02	0.001 - 0.5
Manganese – Mn	0.5	0.05 - 0.5
Iron – Fe	0.62	0.3 - 5.0
Boron – B	0.34	0.05 - 0.5
Molybdenum – Mo	0.05	0.01 - 0.1

The circled results indicate mostly major nutrients. Nitrogen, sulphur, potassium, and calcium are all macronutrients which plants need in large quantities. Most of the micronutrients, or trace elements, are within the acceptable range.

15. What is the most likely explanation of high N, P, K, and S values? How might you get these nutrients back to acceptable levels?

    Overfertilization is the most probable cause. If it is toxic, the soil can be flushed with water to leach the substances out of it. Otherwise, suspend fertilization until the levels are down.

16. Is there a problem of too much salt (NaCl) in the soil? Explain.

    The sodium (Na) level is not yet a serious problem. However, the chlorine (Cl) level is very high. This suggests another source, such as chlorine in the water.

17. How is heat important to growing plants?

    The amount of heat determines the rate of growth.

18. The barrel will be more efficient if it is painted black. Why is this true?

    The colour black absorbs more heat than other colours, and this will cause the water to warm up more than it otherwise would. The heat will also be radiated into the surroundings more readily by the black barrel.

19. How does too much heat affect plants?

    Too much heat (above about 50°C) kills plants – they cannot usually be saved.

20. Energy conservation is part of an efficient operation. List five ways to cool a greenhouse, starting with those that use the most energy, and finishing with those that use the least energy.

    Cooling fans
    Evaporation cooling systems
    Shades and screens
    Roof and side vents
    Plant transpiration

21. What do you think ethylene gas will do to green bananas?

    Ethylene gas will cause the bananas to quickly ripen.

Students can observe the effect that ripened fruit has on green fruit by trying an experiment with green bananas. They can divide a bunch of green bananas into two groups, and place the bananas into separate bags. A ripe banana or other ripe fruit is to be added to one of the bags. Students should then observe the two groups of bananas for several days.

22. Which group ripens more quickly?

The bunch of green bananas with the ripe fruit included will ripen more quickly due to the ethylene that is given off by the ripe fruit.

23. By now you realize that controlling plant environments is a major concern and translates into full-time jobs for many people. Why should this be, when outdoor plants seem to generally get along without human help? Discuss at least three reasons.

Controlled environments allow people to

- *grow crops in a difficult climate*
- *create an ideal environment for special plants*
- *beautify their surroundings with indoor plants*
- *develop higher production levels by controlling the available nutrients*
- *avoid weed and soil pest problems*
- *obtain a better and more uniform quality among the produce*

Section 3: Activity 2

A growth chamber is a structure that provides a unique microenvironment in which to grow plants. The construction of a model growth chamber will give students a practical problem in which to apply some of the concepts from the previous activity.

1. In previous activities you have looked at the environmental factors that could be controlled within a growth chamber. What are these factors?

Factors that can be controlled in a growth chamber include the following:

- *temperature*
- *lighting*
- *humidity and moisture*
- *nutrient application*
- *carbon-dioxide levels*
- *the soil type and condition*
- *pests and diseases*

Students are to do Part A or Part B, and then complete Part C.

Part A

A growth chamber can give your plants a long summer of growth. Because plants get an early start in the spring, you can harvest crops or flowers sooner, or raise varieties that cannot normally be grown in an unprotected garden.

You will require materials, space, and help to set up your structure; however, you should have little trouble finding someone to help, and to share the results of your efforts.

Note: Instructions for building several simple outdoor structures are included with Section 6: A Plant Project. See Project H.

Ask to see your student's growth chamber, or at least a picture of it. Discuss what plants will be grown in the chamber.

Part B

If you are unable to build an outdoor structure, construct a working model of a growth chamber that is made of your own design.

You may build your structure out of materials such as wood, wire, plastic, or sandwich wrap.

In your model you may plant seedlings, rooted cuttings, or seeds in potting soil or a soilless medium. Suitable plants would be radishes or butter lettuce, as these plants grow quickly. If you prefer a vine plant, and are prepared to wait a bit longer, try to grow pickling cucumbers.

Ask to see your student's growth chamber. Discuss what plants will be grown in the chamber.

Part C

1. How does your structure control each of the following for your plants?

   a. Light

      – natural

      Your growth chamber can be placed in the best location to receive the outdoor sunlight. If it is indoors, the chamber can be placed in the best position in relation to the windows.

      – artifical

      You can control the placement of lights in relation to the plants, the duration of lighting, and the types of lights used.

b. Temperature

A cover for the growth chamber will control soil temperature by raising the humidity and reducing evaporation.

c. Moisture

The frequency of watering, an adequate amount of drainage, and a cover to control humidity can be initiated in the controlled environment of a growth chamber.

2. Which plants did you select? Why did you select them for this particular microenvironment?

Answers will vary. Selection is very important for indoor environments containing many types of plants. The plants should be compatible, and they must prefer similar growing conditions.

If several plants are to be grown, they should be plants that prefer the same environment.

Section 3: Follow-Up Activities

Extra Help

1. How would you control the environment to remove the following obstacles to plant growth?

a. cold temperatures

Use a protective cover and add heat to keep the plants warm enough to promote growth.

b. a short growing season

Use artificial lights so there is sufficient light for plants to grow properly.

c. soil that has a nutrient deficiency

You can add fertilizer to soils to make them more suitable for plant growth.

d. dry conditions

You can water the plants more and increase the humidity in the controlled environment.

2. Once the major problems have been solved, growers can really make plants work! Use the information in this module to explain how you would

a. get a fruit to ripen

To get a fruit to ripen faster you could place it in an environment with ethylene gas.

b. "train" a plant to grow the way you want it to

A plant can be made to grow the way you want it to if you prune unwanted branches.

c. make plants bloom in winter

If you manipulate the length of the day, plants can be made to bloom in winter.

d. grow a seedless cucumber

If you spray a plant with hormones to make it react as if it has been pollinated, the plant will produce seedless fruit.

Enrichment

Enrichment A

Visit a local greenhouse or plant conservatory. While visiting, ask questions about such things as temperature controls, humidity, lighting, carbon dioxide levels, pest controls, and the soil condition. Write a short report on how people at the greenhouse or conservatory control the environment.

Answers will vary. Check to see that the reports include answers to such things as how temperature, humidity, carbon dioxide levels, pests, and soil conditions are controlled within a greenhouse or conservatory environment.

Enrichment B

Read the Appendix case study about *The Central Alberta Florist: Growing Division – 1987.* Identify and briefly describe all of the systems that control environments in this type of greenhouse operation. Use the following lines for your response to the Enrichment of your choice.

Environments are controlled in this type of greenhouse operation by the following:

- *Propagation greenhouses – Some greenhouses are used only for seeding and the propagation of plants requiring the same growing conditions.*
- *Watering systems – In this case the automatic watering system includes spaghetti tubes with fertilizer being injected into the water in two out of every three watering cycles.*
- *Lighting systems – Lighting is controlled differently in each greenhouse, depending on the types of plants being grown.*
- *Backup systems – Emergency diesel electric generators are used in case of power failure.*
- *Heating systems – Steam heated by natural gas boilers is used.*

- *Cooling systems – Cooling is accomplished by large roof fans, roof vents, and side walls that swing open.*

The greenhouses are constructed in such a way as to help control various environmental factors and procedures are also in place to control pests. For more detailed descriptions of the systems used to control environments, see the case study included in the Appendix of the Student Module Booklet.

Did the students remember to measure the growth of their plants and fill in the appropriate sections of the Plant Journal in the Assignment Booklet?

Note: The student should now complete the assignment for Section 3 in the Module 2 Assignment Booklet.

Section 4: Controlling Pests and Diseases

Section 4: Activity 1

In this activity students will use real plants as much as possible to reinforce their knowledge of plant diseases. Most houseplants will be in excellent health! Outdoor plants, on the other hand, may show specific problems, particularly when they are brought indoors where predators are not present to keep pest populations in check.

If students plan to examine outdoor plants, these outdoor plants should not be brought indoors near plants where they may start an unwanted infestation.

1. Is there a plant in your home that does not look well? Answer these questions for your plant.

   a. Is this plant new to your home?

   b. Has your potting soil been sterilized?

   c. Have you been watering correctly?

   d. Have you applied nutrients properly?

   e. Is the lighting correct for your plant?

   These questions will help the student identify the problem or problems that the plant may have.

2. Does your plant show any of these symptoms?

   The student should look for the symptoms listed in the module booklet as the plant is examined – these symptoms will help to identify the problem that the plant may have.

3. What is the purpose for isolating a plant if you suspect that it may be diseased?

   Isolating a plant will prevent diseases or pests from spreading to healthy plants.

4. What is the best thing to do with a plant that does not respond to treatment?

   Discard the plant in a place away from other living plants if it does not respond to treatment.

5. How would you treat the following symptoms of disease?

   a. droopy, blackened, and mushy leaves and stems

      Moving the plant to dry conditions may help, but you may have to restart the plant from healthy cuttings.

   b. a whitish, powdery coating on the leaves of your terrarium plants

      This sounds like a mould that enjoys moist conditions. If your plant can tolerate a drier environment, you may try to save it by lowering the humidity and pruning the infected leaves. Dust with a fungicide powder. The problem will probably reappear whenever the air becomes too moist.

   c. ringlike spots appear on leaves

      This may be a pest problem or a bacterial-viral disease. It usually affects only certain plants. If it is serious, cut, burn, or otherwise dispose of the crop. Plant a different type of crop in this area.

   d. rooted cuttings collapse and die

      You should pasteurize the soil or starting media, wash and disinfect the tray, and start again.

   e. black streaks are found on the trunk of a favourite apple tree

      You should cut down and burn the tree. Keep it away from other trees.

6. Check your plant for any of the following signs.

   As the plant is examined, the student should look for the symptoms listed in the module booklet. These symptoms will help to identify the problem that the plant may have.

7. Name the main difference in appearance between one leaf that is attacked by an insect, and another leaf that is suffering from neglect.

   Signs of neglect will usually be related to an environmental problem that needs to be identified. Insects usually leave a visible sign of specific damage – look for tiny pinholes in the leaf, and for pests or eggs on the underside of leaves.

8. In Section 2 you learned about soil sterilization. Why is this done?

   Sterilization kills insect pests and their eggs, plus bacteria and weed seeds.

9. How might washing your plants prevent diseases and insect pests? Suggest two reasons.

   Washing will produce a healthier plant that is more able to resist diseases and pest attacks.

   Washing will also remove pests and their eggs and clean up the mess that they leave – this is a cultural control but not a cure.

Insects are frequently brought into an insect-free house by innocently bringing in an infected plant. Any new plant being brought into the house from a store, garden, or neighbour, should be kept by itself (in isolation) for a week or so to determine if it is a carrier of any insects. If this plant is infected, there will be only one plant to treat or throw out.

Section 4: Activity 2

1. Name the three types of pest controls. Try to give one example of each method.

   The three types of pest controls are

   - *cultural: tillage, washing, handpicking, pruning*
   - *chemical: insecticides, herbicides*
   - *biological: predators, parasites, bacterial diseases*

The videotape *Pest Wars* contains several accounts of how farmers are fighting the battle against pests. This is a good presentation of pest controls for field crops, but similar methods are also employed in greenhouses and gardens.

2. Describe one situation where each of these methods of pest control might be used.

   tillage: *hoeing a garden*
   washing: *removing insect pests from a houseplant*
   crop rotation: *used in fields and gardens*
   weeding: *removing weeds by hand in a garden*
   pruning: *cutting diseased branches from a tree*

3. Give three reasons why the safe use of chemical pesticides is important.

   The safe use of chemical pesticides is important in

   - *protecting personal health*
   - *preventing the pollution of the environment or the contamination of crops*
   - *preventing unwanted damage to beneficial plants and wildlife*

4. Why should you not use chemicals to kill aphids when large numbers of ladybugs are present?

   Ladybugs are an effective type of biological pest control.

5. What is the disadvantage of using sprays in a home?

   Sprays spread around the house as tiny airborne particles.

6. What is the safest method of getting rid of any insects that invade your home or greenhouse?

   Physical controls such as washing, handpicking, and pruning are the safest methods.

7. What is a method used in commercial greenhouses that is not feasible for use in the home?

   Biological controls are effective where there are large numbers of plants.

8. How would you rid a houseplant of spider mites?

   You could wash the plant with ordinary or insecticidal soap to start, then take the plant outside and spray it with an appropriate insecticide.

9. How might you control aphids on an ornamental bush or small fruit tree? Explain the reasons for your choice.

   You could prune severely affected branches, then wash by hosing with a strong spray of water. Finish off by spraying with an appropriate insecticide.

10. How would you control mealybugs on a houseplant?

    Cultural controls such as handpicking, pruning, and washing would control the pest but not necessarily eliminate it. A dusting with chemical powder following a wash could prove effective in controlling mealybugs.

11. How would you get rid of caterpillars in the trees of a park or farm shelterbelt? Explain the reasons for your choice.

    The usual approach is to spray chemical insecticide. An alternative solution would be to spray the bacteria ***Bacillus thuringiensis*** *– this would be a safer choice for a populated area.*

12. Which control would you use in a greenhouse growing long English cucumbers? Why?

    Chemical sprays are not advisable for edible crops. The biological control ***Encarcia formosa,*** *which attacks both larvae and adult flies, could be used.*

13. What is a sure way to prevent an infestation of soil pests?

    Sterilizing soil or using a soilless mix is the best way to prevent an infestation of soil pests in houseplants.

14. Have you ever experienced a problem with weeds? How did you solve the problem?

    Answers will vary. Most students will identify cultural solutions.

15. Name the best method for controlling weeds in each of the following situations:

    a. a small vegetable garden

       Handpicking or hoeing the weeds would be the best methods.

    b. a large greenhouse

       Using soilless media, turning soil between crops, or using chemical herbicides would help control weeds.

    c. a field that has been left fallow (no crop planted)

       Tillage is an effective control for weeds in a field.

    d. a field that has just been planted

       Herbicides can be used effectively to control weeds in a newly-planted field.

    e. a lawn

       Herbicides will help control dandelions or other lawn weeds.

    f. a flower bed populated by ornamental shrubs

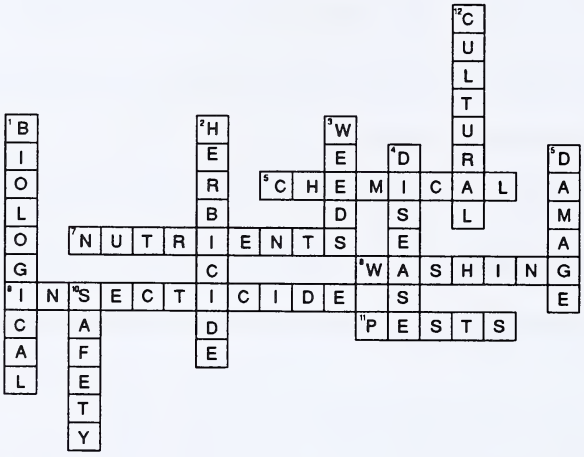
       Handpicking or hoeing the weeds are the best methods for controlling weeds.

Remind students to keep their Plant Journal records up-to-date.

Section 4: Follow-Up Activities

Extra Help

Correction: Have students add two spaces to the top of 2 Down in the Crossword Puzzle. The correct answer to "This chemical is used to kill weeds" is HERBICIDE, but only seven spaces are provided in the Student Module Booklet instead of nine. Supply students with this answer.



Across Clues

6. This pest control works quickly.
7. Weeds compete with crops for these.
8. Use this to keep houseplants healthy.
9. This chemical kills insects.
11. This is the topic of this section.

Down Clues

1. This method of pest control employs other living things.
2. This chemical is used to kill weeds.
3. This pest competes with plants for space.
4. This is a good reason to quarantine (isolate) your plant.
5. Insect pests do this to crops.
10. This is your greatest concern when using chemical pesticides.
12. This means of controlling pests removes them or changes their surroundings.

Enrichment

Enrichment A

Do you have a particular pest problem where you live? Perhaps a neighbour or friend has problems with pests. Read material about a type of pest to discover its life cycle and habits. Then plan a strategy to get rid of it.

If you are unsure what to do in regard to insects or plant disease, contact your nearest office of Alberta Agriculture. People in the office can usually provide you with expertise and information, including many free publications and pamphlets.

Write a short summary about the pest that you researched.

Check to see if the students have a feasible plan to eliminate the insects. Answers will vary.

Enrichment B

With the aid of *Weeds of Alberta* and *Backyard Pest Management*, collect and identify at least ten insects or weeds.

Discuss the collection of weeds or insects. Check to see if the student has a good variety in either case.

Note: The student should now complete the assignment for Section 4 in the Module 2 Assignment Booklet.

Section 5: Frontiers of Production

In this section students explore where greenhouse technology is going and how it may affect the future.

Section 5: Activity 1

1. Write down all of the reasons that you can think of why people might want to grow plants without soil. There are more reasons than you might guess!

   People may want to grow plants without soil because of the following:

   - *The soil in your area is poor or not available.*
   - *You want to obtain higher production levels by controlling available nutrients.*

- *You want to avoid weed and soil pest problems.*
- *You want to eliminate the need for soil reworking and pasteurization, which cause production delays.*
- *You want better quality and uniform produce.*
- *You enjoy the challenge of growing plants without soil.*
- *You are looking for a hobby.*

2. What two plant needs are provided for by the soil?

   Soil, which is a storehouse of nutrients, also acts as an anchor for the plant.

3. How does a hydroponic plant have these needs met?

   People monitor nutrient levels and regulate the supply of nutrients. Plants are anchored in the soilless medium, or are sometimes tied up with string or other material.

4. Describe how you, or someone else, might use hydroponic systems to produce food in a difficult environment.

   Answers will vary. Look for imaginative responses.

Section 5: Activity 2

1. How many possible sources of wasted heat can you identify? List as many as you can.

   Some sources of wasted heat are as follows:

   - *lumber and pulp mills*
   - *power plants*
   - *gas plants*
   - *solar heat*
   - *geothermal (underground) sources*

2. List three types of greenhouse crops grown in Alberta. Try to identify two varieties of each crop. Write the crop names in the three blanks on the top answer lines. Fill in the varieties below each crop name.

   Answers will vary. Common types include the following:

Cucumbers	*Tomatoes*	*Flowers*
long English	*brick red*	*roses*
field	*Roma*	*carnations*
pickling	*cherry*	*lilies*

3. Read the description of the greenhouse operated by Joe and Helen Doef. Make a list of the new methods and technology that they are using to make their greenhouse successful.

   New methods used by the Doef's include

   - *double-walled polyethylene construction*
   - *soilless growing media*
   - *hydroponic systems*
   - *computerized environmental controls*
   - *biological pest controls*

Section 5: Activity 3

1. Write **FACT** or **FICTION** below each of the following:

   a. DNA is found in all living cells.

      FACT

   b. Genes are sections of code on a DNA molecule that help living cells reproduce.

      FACT

   c. Crossbreeding two different types of cucumbers will produce a plant with characteristics of both parent types.

      FACT

   d. Scientists splice sections of DNA from different creatures to create monsters.

      FICTION

e. Scientists can splice sections of DNA in living plant cells to create plants with combined traits.

FACT

f. Mutations are always monsters.

FICTION

2. Examine the list of six agricultural advances. Suggest five ways in which these new plants will help future farmers be more successful.

Ways in which new plants will help farmers be more successful include the following:

- *New products add variety and give people healthier alternatives.*
- *New products form the basis for new industries and successful farming.*
- *New crops can increase the food supply.*
- *Resistance to pests or pesticides can reduce crop losses.*
- *The new products are hopefully kinder to the environment than are current crops.*

Section 5: Follow-Up Activities

Extra Help

Fill in the blanks as a review of this section.

Controlled *environment* agriculture is a new concept where crops are grown under controlled conditions. A modern greenhouse is usually a structure made of *aluminum* and *polyethylene*. It uses *hydroponic* methods and *soilless* growing mediums. Special equipment is used to monitor and control *lighting*, *temperature*, and *nutrients*.

One of the problems to be overcome when operating a greenhouse in a northern climate is the cost of *energy*. One solution is to use *waste* heat produced by industry. *Solar* heat is available to everyone.

Scientists have studied the ways that living things pass on *traits* from one generation to another. These scientists have found a substance in the *cells* of all living things that controls cell reproduction. This is a complex chained molecule called *DNA*. This molecule is like a blueprint, or a set of instructions, to produce the cells that form a living organism. Scientists who work to change this blueprint are called *genetic engineers*. They often use a special method of plant propagation called *tissue culturing*. Plant breeders can *select* plants with desirable traits, and cultivate them to create new plant varieties which meet special needs.

Enrichment

Enrichment A

What have you learned about the Epcot Center?

Check to see what information the student found out about the Epcot Center.

If the student is unable to obtain the book called ***The Future World of Agriculture*** *in the local library, it may be ordered from other libraries, or it can be ordered from bookstores.*

Ask for the following:

Murphy, Wendy. ***The Future World of Agriculture****. An Epcot Center Book, Walt Disney World, Publisher Franklin Watts. New York/Toronto, 1984.*

If you are unable to locate this resource, try to obtain periodicals that deal with new methods of hydroponic gardening, such as ***The Growing Edge****, or* ***The 21st Century Gardener.***

Enrichment B

Let your imagination run wild! Brainstorm with adults, brothers, sisters, or other students to get ideas for the perfect structure in a hostile environment such as Antarctica, the moon, or a space station. Make a drawing of your structure, and label important features.

Drawings and labels will vary. Check for imaginative, creative features on the drawing, but at the same time, ensure that ideas are appropriate for the hostile environments selected by the students.

Check to see that your students are maintaining an up-to-date record of their growing plants in their Plant Journals.

Note: 1. The student should now complete the assignment for Section 5 in the Module 2 Assignment Booklet.

2. Check to see that all assignments have been completed and that all written work is done neatly in blue or black ink. Diagrams may be left in pencil.

3. The completed Assignment Booklet for Module 2 should now be submitted to the Alberta Distance Learning Centre for correction. The assignments for Section 6: A Plant Project are evaluated as part of Module 4.

Section 6: A Plant Project

Student projects are included in the Agriculture: Land and Life Year Two course to allow students to pursue personal interests. A choice of plant projects have been included at this time to allow time for hands-on experience with plants. A library research project (Project D) is suggested for those students who prefer this method of completing the course requirements, instead of growing plants.

Note: Section 6: A Plant Project is to be done only by those students who have previously completed Agriculture: Land and Life Year One. If this course is the student's first enrolment in the Agriculture: Land and Life program, then the plant project is to be omitted – Part A: What Is Agriculture? in Module 4 will need to be done instead.

The type of project students select will vary. As a result not all of the activities in Section 6 are critical to the completion of any one individual project. The activities in Section 6 are included to assist students with the planning and completing of assignments regarding the plant project in the Module 4 Assignment Booklet.

Section 6: Activity 1

Students should use this activity to select a project and set reasonable objectives. This was probably done when students completed Section 2 of this module.

1. What kind of plant project would you like to do? Write down your thoughts.

   Answers to this question will vary. If students are not able to raise a plant, they should do a crop research project.

2. Write down your choice.

   Answers will vary. Student choices will include one of the following.

   Project A: Collect and Test a Variety of Seeds
   Project B: See the Effects of Fertilization
   Project C: How Does Lighting Affect Plants?
   Project D: Crop Research
   Project E: Grow a Plant with Hydroponics
   Project F: Growing Crops and Weeds
   Project G: Create a Terrarium for Plants
   Project H: Create an Outdoor Growth Chamber

3. Write down a list of your materials.

Answers will vary. Compare student lists with the project description. Each project will need special equipment and materials. A student's ability to do the project may depend on the availability of these materials – if necessary, try to suggest alternate materials. Don't forget materials for propagating and transplanting.

Students should check and discuss their plans with their learning facilitator. Please ensure that their choice of project and goals can be achieved.

Students should now complete Assignment 1 in Part B: Project 1 – A Plant Project, which is located in the Module 4 Assignment Booklet.

Note: The project assignments are included as part of Module 4 to allow students time to work on their projects while continuing to work on other modules.

Section 6: Activity 2

Several sources of information are suggested to help students with this part of their project.

If students are growing plants, they may have to look for more information in the library, refer to the unit on growing plants in the textbooks which accompany the Science 8 course, or talk to a knowledgeable person.

If students plan to do a Crop Research Project, they should make a rough outline of the topics to cover, then look for reference materials, such as home gardening books and encyclopedias, to supply information on these topics.

Written reports must cover the following topics:

- **a description of the origin and history of the plant's cultivation**
- **the environment required for growth**
- **where the plant is grown**
- **how the plant is grown**
- **how it is sold**
- **how the plant is processed**
- **what foods or other products are made from the plant**

Another source for information is the Information Services Division of Alberta Agriculture. This government department has many free publications on the growing of houseplants, vegetables, and field crops. A complete list of publications is available from your District Agriculturalist or from the following:

Information Services Division
Alberta Agriculture
7000-113 Street
Edmonton, Alberta
T5T 2S7

Students should now complete Assignment 2 in Part B: Project 1, which is located in the Module 4 Assignment Booklet.

Section 6: Activity 3

This activity is included to help students plan steps to achieve their objectives. Some sample tasks are mentioned in the Student Module Booklet.

1. Make a list of all of the tasks that need to be completed as part of your project. Then number each task in the order that it must be done.

   Answers will vary from project to project. This list will help students prepare a flow chart in the Assignment Booklet.

2. Use a symbol (*) to indicate which tasks in the previous list will require you to gather further information.

   This will help students identify further tasks.

Students should now complete either question 1 or question 2 for Assignment 3 in Part B: Project 1, which is located in the Module 4 Assignment Booklet. Question 1 is to be done by students who are growing plants. They can use the list of tasks completed for this activity to help them complete a flow chart. Question 2 is to be done by students who are doing a Crop Research Project.

Section 6: Activity 4

This activity is related to the main assignment for this project. The assignment will be one of two different tasks depending on the nature of the project. This activity supplies guidelines for

- **record keeping and growing plants in a controlled situation**
- **preparing a written report on a particular plant**

A journal can be a tool to help students organize regular visits to measure or monitor the plants. As part of this project, students are to set up and keep a Plant Journal in the Module 4 Assignment Booklet. When making a visit students should record

- **the date**
- **what was done (such as watering or fertilizing)**
- **measurements of plant heights**
- **observations about changes in plant growth (first shoot, first leaf, first bud)**

Students should now complete either question 1 or question 2 for Assignment 4 in Part B: Project 1, which is located in the Module 4 Assignment Booklet. Question 1 is for students who are growing plants. Question 2 is for students who are doing a Crop Research Project.

Section 6: Activity 5

This activity supplies guidelines and information which should be followed to complete the assignment for the final report. After reading the information, students should complete Assignment 5 in Part B: Project 1, which is located in the Module 4 Assignment Booklet.

Check that students have completed all assignments for their plant project and have this part ready to submit when they have completed both this project, and the animal project, which is described in Module 3.

Agriculture Year 2

9AG07P62

L.R.D.C.
Producer

FIRST EDITION
1992